

November 12, 2013

MEMORANDUM FOR: JOHN CONTI
ASSISTANT ADMINISTRATOR FOR ENERGY ANALYSIS

FROM: ANGELINA LAROSE
TEAM LEAD
NATURAL GAS MARKETS TEAM

JOHN STAUB
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EXPLORATION AND PRODUCTION ANALYSIS TEAM

EXPLORATION AND PRODUCTION and NATURAL GAS
MARKETS TEAMS

SUBJECT: Second AEO2014 Oil and Gas Working Group Meeting Summary
(presented September 26, 2013)

Attendees:

- Robert Anderson (DOE)
- Peter Balash (NETL)*
- David Bardin (self)
- Joe Benneche (EIA)
- Philip Budzik (EIA)
- Kara Callahan (OnLocation, Inc.)*
- Ron Charpentier (USGS)*
- Troy Cook (EIA)*
- Jeffrey Eppink (Enegis)
- Aloulou Fawzi (EIA)
- Michael Ford (EIA)
- Michelle Foss (UTEX Houston)
- Adrian Geagla (EIA)
- Ron Gecan (CBO)
- Michael Godec (Advanced Resources)
- Samuel Gorgen (EIA)*
- Leslie Goudarzi (OnLocation, Inc.)*
- Steven Grape (EIA)
- Gurcan Gulen (BEG, UTEX)*
- Tanya Heebsh (Natural Gas Partners)*
- Trevor Houser (Rhodium Group)*
- Svetlana Ikonnikova (BEG, UTEX)*
- Robert King (EIA)

Steven Kopits (Douglas Westwood)*
Vello Kuuskraa (ARI)
Angelina LaRose (EIA)
Carol Lenox (EPA)*
Gary Long (EIA)
Alex Macpherson (EPA)*
Arup Mallik, (EIA)
David Manowitz (EIA)
Scott Mitchell (Wood Mackenzie)*
Jack Perrin (EIA)*
Chetha Phang (EIA)
Gavin Pickenpaugh (NETL)*
John Pyrdol (DOE)
Darryl Rogers (IHS)
Michael Schaal (EIA)
Ben Schlesinger (BSA)
Michael Scott (EIA)
Charles Sheppard (EOG Resources)*
David Shin (API)
Thierno Sow (BOEM)*
John Staub (EIA)
Katherine Teller (EIA)
Lynsey Tibbs (Southern Company)*
Douglas Tierney (Encana)*
Dana Van-Wagener (EIA)*
Maria Vargas (NETL)*
Harry Vidas (ICF)*
Charles Zelek (NETL)*

*Attended via WebEx

Presenters: John Staub (OGSM)
Angelina LaRose (NGTDM)

Presentation:

The presentation provided an overview of the preliminary AEO2014 reference case projections for the Oil and Gas Supply Module (OGSM) and the Natural Gas Transmission Distribution Module (NGTDM).

For oil and gas supply modeling, the following preliminary AEO2014 oil and gas cases, assumptions, and projections were presented.

For liquid fuels:

- AEO2014 high, low, and reference oil price cases

- Projected liquid fuels consumption, production and imports
- Projected liquid fuels consumption by consumption sector
- AEO2014 lower-48 unproved tight oil resources
- Projected crude oil production by source
- Projected lower-48 onshore oil production by source
- Historical tight oil production by formation
- Projected crude oil production from specific tight oil plays

For natural gas:

- AEO2014 lower-48 shale gas resources by formation
- Projected shale gas production by formation
- Projected natural gas consumption, production and imports/exports
- Projected net U.S. gas imports by source
- Projected LNG exports out of North America by region
- Projected Henry Hub spot natural gas prices
- Projected Henry Hub spot natural gas prices compared to IHS/CERA projected prices
- Projected end-user natural gas prices by consumption sector
- Projected natural gas consumption by consumption category
- NGTDM model enhancements for the AEO2014

Questions and answers:

- 1) Are other crude oil benchmark prices (e.g., Louisiana Light Sweet) used within the OGSM model to evaluate project economics?
EIA response: OGSM distinguishes crude oil pricing by crude type (light sweet, heavy sour, etc.) and regional location in evaluating project economics.
- 2) Do the AEO high/low oil price cases assume a more/less plentiful supply of world oil?
EIA response: Yes. Those cases also consider alternative world GDP growth rates.
- 3) The implied OGSM price/supply elasticities across price cases seem low for natural gas; why is this the case?
EIA response: OGSM is a process model without an explicit supply curve. Some analysts have calculated the implied supply elasticity in the model by comparing different cases published by EIA in prior AEOs. However, because the supply response to change in price cannot be isolated from the demand response to change in price, using this case-level approach does not offer a pure supply elasticity. Additionally, due to changes in the modeling approach for production (i.e. modeling production at the county level), it is likely that the implied supply elasticities have increased compare to previous AEOs.
- 4) Does projected crude oil production and consumption include NGL?
EIA response: We account for the production and consumption of NGLs in the NEMS model. The reported crude oil production includes lease condensate, whereas

natural gas plant liquids are reported as a separate line item in the liquid fuels supply and disposition table. Liquefied refinery gases are handled separately.

- 5) Where in the industrial sector is natural gas plant liquids (NGPL) consumed?
EIA response: Industrial NGPL consumption occurs in both the petrochemical industry and in oil & gas refining industry. In the petrochemical industry, NGPL is consumed as a feedstock primarily in the production of plastics precursors, such as ethylene and propylene. In the refinery industry, NGPL is consumed as a fuel (ethane) or blended into gasoline and distillate fuels (e.g., isobutene and pentanes plus).
- 6) Is there any particular constraint in OGSM that is the most important in determining the Reference Case projections?
EIA response: Resources, and the costs associated with producing them, dominate when and how much crude oil and natural gas are produced under specific economic conditions.
- 7) Does OGSM have the ability to model different state royalty rates and changes in those royalty rates?
EIA response: Yes, OGSM includes these costs.
- 8) Do state royalty rates affect the economics regarding well drilling and abandonment?
EIA response: Yes, OGSM includes these costs in estimating the economics of drilling and producing a well, including when a well is abandoned.
- 9) How do overriding royalty rates affect the well economics as original lease owners sell their lease property rights to another party?
EIA response: This is not modeled because no public data on this matter is available.
- 10) Does OGSM incorporate any logistical constraints to developing well acreage such as the lack of roads in hilly or mountainous terrain?
EIA response: Not directly. However, the drilling costs used in OGSM are specified by OGSM region and thus reflect remoteness and other location constraint differences between those regions.
- 11) How does well spacing assumptions dictate how many wells can be drilled?
EIA response: As well spacing is reduced, more wells would need to be drilled over the same acreage to produce the play. Minimum well spacings are used to limit well interactions. As more information becomes available, well spacing estimates are adjusted to better reflect what is happening in the field.
- 12) Do OGSM's estimated ultimate recovery (EUR) rates for wells change as drilling migrates outside of the "sweet spot" areas?
EIA response: Yes, as producers deplete sweet-spot resources, the average EUR per well declines, so over the projection time frame, the average EUR per well declines for shale gas and tight oil. OGSM's EUR per well estimates are done at the county

level, thereby, the decline in the average EUR per well is modeled and is reflected in the development profile of the resources.

- 13) Have the OGSM developers spoken with State agencies and regulators regarding the AEO projections; and have any such discussions impacted the model or its projections?

EIA response: Yes, we talk with and gather data from state and federal regulatory agencies to understand how development of the resources may progress. These discussions include topics like well spacing permit changes, leasing and resource estimates on public lands, etc.

- 14) What causes the rise in Alaska oil production in the middle years of the reference projections?

EIA response: The discovery, development, and production of new offshore oil fields in the Beaufort and Chukchi Seas during the projection period.

- 15) Is it too late to incorporate in the AEO2014 Reference Case information on new CO₂ EOR projects?

EIA response: Please forward any list(s) of new CO₂ EOR projects that you might have. As time and resources permit, the new information regarding those new CO₂ EOR projects will be incorporated.

- 16) Is residual oil zone (ROZ) CO₂ EOR present in OGSM and the projections?

EIA response: Residual oil zone oil resources are not explicitly represented in OGSM.

- 17) What is the rate of technological change in OGSM?

EIA response: The rates of technological change vary for different types of formations and technologies.

- 18) Are new CO₂ supply sources for new CO₂ EOR projects in OGSM and the projections?

EIA response: Yes, especially from electricity generation sources.

- 19) Is oil and gas well drilling constrained by drilling rig availability?

EIA response: No, rig availability is a short-term condition that the drilling industry will resolve based on the economics. OGSM does not represent short-term drilling constraints. Although the number of drilling rigs in the real world can be a constraint, rig shortages are short duration events as new rigs are built to meet the perceived current and future demands.

- 20) Do U.S. LNG export facility utilization rates vary over time?

EIA response: Yes, in AEO2014, U.S. LNG export facility utilization rates can vary (i.e., fall below the assumed maximum sustained utilization) depending on the relationship between U.S. LNG supply price and the representative international natural gas price.

21) What changes do you see in Mexican shale gas production?

EIA response: We largely base our Mexican natural gas production projections on projections generated for the latest EIA's International Energy Outlook. For the most part, we have not made an adjustment to take into account any potential change due to recent activities in Mexico attempting to increase participation by private companies.

22) How are Asian LNG import prices determined, and if they do vary, how does that impact the level of U.S. LNG exports?

EIA response: International natural gas prices representing both Asia and Europe are modeled to reflect the belief that international prices currently have some level of oil-linkage and with the growth of flexible—or spot—LNG in the market, the price will start moving away from that oil-linkage. All else being equal, the faster the price delinks from oil, the lower the potential of U.S. LNG exports.

23) If Japan were willing to pay a premium for LNG above the price determined by oil prices, how would that impact U.S. LNG exports?

EIA response: The model compares U.S. LNG supply prices to representative Asia and Europe natural gas prices, determined as described in Question 23. A country's willingness to pay a premium for LNG above the prices determined by oil prices is not modeled.

24) How does the NGTDM trade-off between LNG spot prices and trades versus long-term LNG commitments at relatively fixed prices?

EIA response: EIA assumes that there will be growth in flexible (i.e. spot) LNG volumes during the projection period. The growth in the flexible LNG volumes comes from new LNG export capacity, as well as long-term LNG contracts ending. The growth in these volumes helps pull international prices away from an oil-linked price.

25) Would Gulf of Mexico LNG exports go to Asia?

EIA response: Based on the economics, they would be sold into the Asian LNG market, but their physical destination may be elsewhere.

31) It is desirable to have long-term supply curves for oil and gas production.

EIA response: The OGSM is a process model that does not explicitly incorporate long-term supply curves regarding oil and gas production. The OGSM model explicitly represents, for example, time lags between the initiation of oil and gas production investments and the commencement of production. In contrast, supply curves are unable to represent those development time lags.

32) Is potential gas consumption in drilling rigs modeled in the industrial sector consumption model?

EIA response: Natural gas used on the lease is projected within the Natural Gas Transmission and Distribution Module as a function of the amount of natural gas produced, while oil consumption on the lease is projected in the NEMS Industrial

Demand Module. We recognize that there has been and will continue to be some switching from oil-based fuels into gas, more likely LNG. We have yet to specifically capture this in the model.

33) How is off-grid electric generation modeled?

EIA response: NEMS largely projects off-grid electricity generation within the NEMS demand models, of which we are less familiar.

34) How is flared gas represented in the model?

EIA response: Gas flaring is not directly modeled within OGSM. Gas flaring is viewed as a short-term rather than long-term phenomenon because 1) producers have revenue and profit incentive to sell gas rather than flare it, and 2) gas flaring is limited by state regulatory agencies and is only permitted until the necessary infrastructure is built.

35) How is commercial building gas consumption determined?

EIA response: NEMS models commercial building natural gas consumption within the commercial sector energy demand model.